ation of plates taken by M. Blajko. The star is not in the D.M., and has the following position :—

R.A. oh. 28m.
Decl. + 79° 33′ } 1855.

The brightness varies from between 8-9 to about 12 magnitude. It was increasing in October 1896, and decreasing in October 1897 ; it was almost at minimum during May 1898, April 1899, and at commencement of May 1900.

EPHEMERIS OF EROS.—Herr F. Ristenpart communicates a revised ephemeris of this planet to the *Astronomische Nachrichten* (Bd. 152, No. 3643), as follows :—

Ephemeris for 12h. Berlin Mean Time.

1900.	R.A.	Decl.
	h. m. s.	° ′ ″
June 21 ...	0 30 15·44 ...	+ 9 57 27·1
23 ...	33 42·19 ...	10 33 33·6
25 ...	37 8·20 ...	11 9 49·0
27 ...	40 33·44 ...	11 46 13·3
29 ...	43 57·91 ...	12 22 46·6
July 1 ...	47 21·57 ...	12 59 29·0
3 ..	50 44·44 ...	13 36 21·0
5 ...	0 54 6·51 ...	+14 13 22·3

HOWE'S PHOTOGRAPHIC OBSERVATION OF EROS.—Mr. A. C. D. Crommelin writes to point out an error in our note on the above, in which it was incorrectly stated that Prof. Howe's photographic observation of Eros was obtained during the solar eclipse of May 28. The photograph was taken before sunrise on the morning of the eclipse, some hours before totality. The error was introduced by the report of the observation being included in reports of the eclipse, and if uncorrected might lead to wrong estimates of the comparative brightness of the planet and of the darkness of the sky during totality.

A MODERN UNIVERSITY.

I.

THE granting of a Charter to the University of Birmingham, which has just become an accomplished fact, forms a fitting climax to an educational movement which may turn out to be one of the most momentous of the century. We have seen University Colleges called into existence in the great cities of the land by the perception of leading citizens that culture and scientific education of a high type must be brought to their doors and made accessible to all ; and we have seen the chairs of those colleges occupied by men who have devoted their spare time to the advancement of learning in various ways. All this has been of the greatest interest in the past and is full of hope for the future.

Side by side with these colleges there is now growing up in many cities a Technical School generally under Municipal Government, wherein artisans and hand workers generally may be trained in their craft, and in the main principles underlying it, in a more direct and satisfactory manner than by the old system of apprenticeship.

Such schools can no more turn out a finished artisan than the colleges can turn out a finished scholar. Much remains to be learned in later life and in the actual pursuit of trade or profession, but the early stages are overcome not only more rapidly, but far more thoroughly, by aid of direct instruction ; and in the more favourable cases a substratum of scientific knowledge is laid, and a grasp of principle attained, which must be of the utmost benefit hereafter, and could never have been obtained on the old plan. It is this scientific training in principles which is the really needful thing, when the public is educated enough to perceive it ; it is this which is of interest to the educationist, and not a mere instruction in handicraft : it is the making of men, and not the making of machines, which is of vital importance to the future of a country.

Without a training in principles a man remains ignorant and narrow, limited to the performance of the one thing which he has been trained to do, and incapable of turning his attention profitably to anything else ; inelastic and incapable of devising or of assimilating modifications and developments, which, as they come in, tend to leave him stranded and belated, waiting only for a period of slacker demand to throw him out of employment. And even if the artisan and the foreman are well educated, there remains his employer to be considered. If he is ignorant—too ignorant to turn his enterprise in the right direction when opportunity offers—his workers must suffer, and the whole nation suffers with them. But though Colleges and Technical Schools impart education on the one hand and instruction on the other ; though they enlarge and make more real the education available to the average citizen, they do not control and modify the educational ideal of the country. That ideal remains in many respects still essentially the same as it was at the beginning of the present century, before all this amazing inrush of new knowledge. The new knowledge has not yet been incorporated into education. The half-hearted effort made by schools to introduce what they term a "modern side" only serves to emphasise the blankness of the prospect. They say, and say truly, no doubt, that the new studies do not answer. They do not pay either for Government appointments or for the university. But a new university, able to set its own standards, select its own faculties, and set its seal on students of its own subjects, has far larger possibilities before it. It can control, and not only impart, edution. It may need an effort to rise to its privileges. The easiest plan is to follow the lead of others and establish degrees on the worn old lines, but that is not what we expect and hope from the new university of the Midlands. We hope to see it break away from mediæval traditions and realise the need there is for a new educational ideal.

The aim we have before us is an aim at actualities rather than at artificialities ; at real things rather than at conventions.

There is a stage of thoroughness at which a study of the conventionalities of grammar and orthography is able to convey real information about men and things—the advanced stage when it becomes the science of philology—but as usually learnt by ordinary persons it is little better than a conventional code and set of rules. If there was little in the world to learn about—as in the middle ages there was but little—it might be well to spend much time in acquiring precisely the gender of nouns and the terminations of irregular verbs in different foreign tongues ; not only for practical purposes but for mental training ; but amid the superfluity of real subjects of the present day, of all of which the ordinary person is densely ignorant, to immerse him for a long period in these barren studies is wasteful of his youth.

On the other hand, History is reality ; and some knowledge of history is necessary for every one. Art, again, and Literature and Music are, or may be, realities ; and the vast majority who have no power of creation should at least learn reverently to appreciate the great work of the greatest masters in all subjects, unless they are deaf and dumb and blind. The things really valuable to the human race should be made in some degree accessible to all, and this part of the work of education the Press and the Stage indirectly in some degree accomplish ; imperfectly, no doubt, but often more really than do the bodies which make the attempt in a more academic way.

Thus we would discriminate between the conventionalities of language and the realities of literature, just as we discriminate between the laws of colour and perspective, the technique of the painter on the one hand—and the great work of art itself, the expression of a thought or of an emotion, or of a beauty or of a fact. To the scholar, as to the painter, the two are inextricably interwoven ; technique is the material in which he works ; but the general human race, who have to do the work of the world, and who constitute the bulk of the nation, are neither scholarly nor artistic, and it is both wasteful and cruel to plunge them into technique, and disgust them with the—to them—dull and meaningless details, instead of educating them in the finished work possible only to masters of the craft.

The same sort of things do we say of science and of mathematics. Here, again, there is too great a tendency to educate youths in subtleties and artifices and minutiæ, as if they were going all to be accomplished mathematicians or men of science. The teacher is himself, perhaps, a mathematician, and so thinks that what was necessary for him is suitable for everybody. More usually, of course, the teacher knows very little about it, and feels only that he was himself taught that way, and that he must pass it on. Only a few stop to think what they are doing, and these are the educationists ; what they have to say is written at large, and there is no need to repeat it. Some of them are faddists, doubtless ; not all are wise ; but it is well at any rate to try and think a matter out ; and the speculative teaching even of a faddist is likely to be more stimulating than the tenth-hand droning of a conventional pedagogue. To indicate our meaning in terms of mathematics and science, as we have tried briefly to indicate it in the domain of more humanistic studies, we would say that a good deal of the teaching of Euclid

and algebra and trigonometry is conventional, and unsuitable to the average youth. If a youth is going to be a mathematician, it matters very little how he is taught these things, so long as they are put in his way. He can hardly have too much of them, he can look at them every way and they present no difficulty; but even the young mathematician might be saved the wearisome and long continued grind through the conventional books of Euclid, with the result that at the end he knows about as much geometry as a month of reasonable teaching would have given him. It is not mathematics at all that he is studying when he is doing Euclid in the usual way, it is a piece of old world literature, very admirable in its proper place, no doubt, and read through at a fair pace quite interesting. It is at any rate far more interesting than the military despatches with which so large another portion of his time is usually, at the same time, being burdened—a form of literature which is not of the slightest interest, and leaves no residue of real information in his mind, except that Gaul used to be divided into three parts; that Cæsar's army built an ingenious and highly technical bridge; that he had difficult times in conquering a people who are not our ancestors, but who happened to occupy the same plot of ground on the earth's surface as we do now.

The conventional part of algebra we refer to may be illustrated by G.C.M. and other rules which in actual work are never needed or employed even by mathematicians. Factors and Equations and Progressions are well enough,—all those parts that are really used or likely to be used hereafter, and all those parts which give a firmer grasp of principles.

Thus in arithmetic, familiarity with such a subject as scales of notation—with the principles, that is, of Arabian numeration—will be really educative and far more helpful than excessive repetition of a rule called "practice," and much dealing with commercial articles. A variety of problems from mensuration, mechanics and heat might be introduced into arithmetic, and the subject made more living than it is apt to be. Mensuration and practical trigonometry may be made truly educative subjects, and a quantity of arithmetical exercises may be founded upon things actually done in the workshop, the laboratory and the field, in the working out of which boys might readily be got to take a real interest.

But all these are school subjects. What have they to do with a university? They have a great deal to do with it in reality, for it is one of the functions and the privileges of a university indirectly to control, or rather influence, the schools. The influence is quite natural and unavoidable anyhow, but on the side of exhibitions and scholarships it becomes obvious and direct.

The schools must train largely for the universities, and the universities must train largely for life.

Now it is just in this training for life that the universities have proved deficient. The only life they have contemplated has been that of the politician and the lawyer on the one hand, and the scholar and recluse on the other. The kind of training needed or supposed to be needed by the past generation of statesmen has been supplied—with results not wholly and completely satisfactory; the kind of training needed for the highly specialised scholar has likewise and will always be supplied. The ancient universities are the natural homes of this kind of learning, and no modern institutions can hope or should attempt to compete with them. The aroma of centuries is a unique growth, and should be carefully fostered and reverenced by a busy and pushing generation.

It would be a calamity if anything were done to destroy the peace and old world quiet of mediæval institutions, founded on monastic traditions and full of attraction for the few who are called to be learned. That Oxford should specialise in archæology and ancient philosophy is most appropriate; that it should regard with jealous eyes the learning of the present century, and hesitate about letting its old bottles be endangered by the inclusion of new wine, is natural and may be wise. We would urge its custodians jealously to preserve the old learning, and leave experiments in new developments to younger and less fragile growths. We would treat the old universities like old buildings, relics of the past, to be most carefully preserved, and supplying something in the life of the nation which no amount of energy or reforming spirit is competent to supply.

If this old world atmosphere disappears it is an irreparable loss. Let its custodians be jealous and conservative; if they see no way of engrafting the new learning on the old stock, without ruining it, then it were far better that the new learning should be planted in fresh soil.

Such soil is furnished by natural circumstance at the intersection of great trade routes, at the market places of the world. Here the average man is at his strongest and busiest, here he is most actively in touch with life on this planet, and is serving his day and generation with an energy which is unmistakable. The motives, doubtless, are mixed, and the results are mixed, there is little Utopian about them; yet there is real self-sacrifice for a far-off good instinctively felt. Ugly surroundings are put up with, as a concomitant apparently necessary, and as at any rate temporarily unavoidable; and life is lived hard for an end not often clearly grasped, yet powerfully felt to the uttermost parts of the Empire. It is on such strenuous home industry, of director, of manager, of foreman, of artisan and of salesmen that our empire is established; and if there is one thing that we are more powerfully realising at present than another it is that our empire must be consolidated, that fresh guiding force must be available, not mere energy—of that there is plenty—but more directing force, more intelligent guidance, more discrimination, more breadth of view—in a word, more real education.

The present war will wake the people of these islands out of their comfortable lethargy. They will see that to hold our position in the modern world we require improved training, not only in rifle shooting and artillery practice, but in every department of activity. Other nations are leaping to the front and spending public money lavishly to get their people better educated, better fitted for seizing new ideas and applying them; it will never do for us to lag behind.

A few scholars, a few men of science, a few men of genius in various branches, these will not save a nation. They extend its fame, they adorn it, they stimulate it, and they reward it; but the backbone of a nation is the average man, the average man of affairs, the man who does the business of the world. If he breaks down or is crippled, the ornamental head cannot be supported. He may be a professional man or a merchant, or he may be a manufacturer or a tradesman, but whatever he is, he must not rest on his oars and be content with the tradition of the past. We are entering a new century, many traditions of the past are out of date, and the vital thing for the nation to realise, if it is to maintain its hard won supremacy, is that antique methods of education will no longer serve. They have had their day; they need not yet cease to be, but they must be supplemented by others. The modern university must take care of the average man. Plenty of long-established universities will look after the high honours men, and in every department highly specialised training is already available; our artisans are as skilled, each in his narrow groove, as it is possible for man to be—marvels of mechanical skill they are; but where is the breadth of view, the elasticity, the power to modify, to invent, to reform, to seize new conditions, to adapt one's self to the growing and changing needs of the world? A foreign order comes to an engineering works of the present day with its sizes expressed in decimals. Before the order can be given out it has to be interpreted into the clumsy sixteenths and thirty-seconds and sixty-fourths of an inch, which alone the workman understands.

Nor is this portentous ignorance limited to workmen. Directly the domain of science is touched, your ordinary school-trained average man is stranded—he is ignorant even of the scientific alphabet—scientific principles are a sealed book to him: the divorce between science and practice, except in the case of a few leading firms who have already wakened up like their continental confrères, appears to be complete.

The modern university must aim for a long time not at depth so much as at breadth. Depth for the few, breadth for the many. It must seek to turn out all-round men, and not specialists only.

Its graduates should not one of them be illiterate, not one of them ignorant of the fundamental principles of science. Trained scientific men they cannot be, in any numbers—the idea would be absurd—but they should have sufficient education to understand a scientific question and know where to go for the answer. They should have lived for a time—even a short time—in the atmosphere of science, and thereafter it will never be quite strange to them.

The scientific training need not be given solely in an academic manner, aloof from all questions of practical interest.

Some people are best trained in this manner, but other persons with a vivid practical interest or experience in application to life and work are best trained in close touch with practical conditions. Medical training is the best example ; that is thoroughly done. We would have other training arranged on the same practical lines. The modern university will seek, so far as it can, to allow for differences of aptitude, or, it may be, differences of preliminary training. It will not seek to force every undergraduate at first through an arts course, and then through a science course, and then through a technical course. It may be well to do this with professional men, but not with all. Every graduate should pass through these three stages before he can be turned out a useful and educated citizen, fit intellectually to take his share in the work of the world ; but he need not in every case of necessity take them in this logical order.

To force a boy through a course of language or history or literature, at a period when for some reason he is not attracted by it, is doing him but little good. It may, indeed, do him harm, by breeding disgust for subjects which at a later stage he might realise were necessary, and, when properly taught, enthralling. It is love of culture, and not hatred of it, that should be implanted. The so-called "preliminary in arts" course should be taken compulsorily at some stage of a graduate's complete career, but not necessarily at the beginning A student who has been immersed for a term in purely technical studies will, if he is good for anything, turn to such human subjects with relief; and it is not fair to turn him out in the world without some worthy human interest and solace. The university has failed in one of its functions if it permits him to depart trained in nothing but unhuman technology.

But then, on the other hand, the arts man, the lawyer, the merchant, the man of business, and still more the teacher—how much better would they not be for a tinge of scientific training. Their ignorance does not come home to all of them, but to many it does ; and probably in middle life they strive, by attending popular lectures and miscellaneous semi-scientific entertainments, to obtain a growth by a top-dressing of superficial information never really assimilated, seldom adequately understood. A manuring of science placed low down when young would have rendered the surface soil fertile, and this later growth easy, just as the youthful smattering of letters renders moderately easy and interesting the subsequent reading of history, or, in some cases, even the learning of a new language ; but to the wholly untrained person these things are, and remain, hopelessly difficult.

A broad training all round can only result in what specialists would call a smattering—what we should prefer to call a leaven ; but so long as it is not confined to a learning of trivial details, but represents a grasp of some of the fundamental principles of a subject, it is all that most men ever have, or can have, in any branch but their own, however highly educated they may be. It takes a very exceptional man to be really learned, or to be able to say anything really worth hearing, off his own subject. There are men who make a large portion of knowledge their province, but the majority of men cannot and should not aim at this. They should know one thing well, and in all else they should not be entirely ignorant.

This absence of entire ignorance is a far more valuable commodity than is usually supposed. It enables the man of affairs to consult specialists with advantage. Special knowledge is always available, if one knows how and where to look for it ; but the man of complete ignorance is at the mercy of every charlatan ; he puts his money into the wildest scheme, on the one hand, and on the other he fails to realise possibilities of sound application lying all about him. His enterprise and power may be great, but the blight of ignorance makes him useless ; and it is just this blight which is endangering our continued industrial and commercial supremacy among the nations of the world.

We look to the new type of university now about to be created to remedy this state of things. If Birmingham succeeds in its high emprise, other great cities will follow suit. The experiment is one that is of interest to the whole British Empire, indeed to the whole Anglo-Saxon race.

In another article we may perhaps enter more into detail concerning some of the features of the scheme ; but it is at present in such extreme infancy that its features are barely recognisable. It does not follow that what is immediately to the front is in reality the most important or the most characteristic.

(*To be continued.*)

THE STEADYING OF SHIPS.[1]

THE evolution of the modern flat-bottomed merchant vessel, with its midship section of approximately rectangular form, from its old pointed-bottomed prototype, with deep central keel, has been a necessary result of commercial competition. The naval architect is called on to increase the carrying capacity of his vessels to the utmost extent, and a limitation is imposed on their draught of water by the limited depth of harbours, docks, rivers and, last but not least, ship canals. The old central keel has had to disappear in order that the extra foot or two of displacement might be utilised for the carriage of cargo, and a substitute has had to be found for it by the attachment of "bilge-keels" or side keels projecting from the ship at the only places where they could be placed without taking up valuable space—namely, at the two rounded-off corners of the rectangular section.

The efficiency of bilge-keels in modifying the rolling oscillation of ships seems to have been for some time a debated point among naval architects, and the experimental fact that the extinction of oscillation produced by these keels may in some instances be many times—possibly as much as ten times—that which would be inferred from determinations of the resistance of a paddle oscillating in water certainly appears at a first glance paradoxical. On reading Mr. Luke's paper in the *Transactions* of the Scotch Shipbuilders, and subsequently Sir William White's account of his experiments on the *Revenge*, it occurred to me that the properties of discontinuous fluid motion, so long a favourite study among mathematicians, might be put to a useful purpose in explaining the high resistances to rolling observed with the use of bilge-keels. So far from these resistances being in contradiction with the principles of hydrodynamics, they appeared to be to a large extent in conformity with our theory of free stream-lines, and this view has been borne out by subsequent calculations, certainly to a far greater degree than I at first anticipated.

According to hydrodynamical theory, if a solid body is set moving through or rotating in an unlimited mass of perfect fluid previously at rest, the motion will continue indefinitely, provided that the body has no sharp edges or corners projecting into the fluid, and that the velocity does not exceed certain limits. The motion involves no continuous expenditure of energy, and if the solid is brought to rest, the fluid will come to rest, and the energy which was expended in starting the motion will be recovered. If, however, the body has any sharp projecting edges, the fluid is unable to flow continuously round these, and discontinuous motion is set up, a mass of dead water being dragged along behind the projecting edges, and this dead water being separated from the moving fluid by a "surface of discontinuity" in crossing which the velocity changes abruptly. In this case the fluid motion is not destroyed when the solid is brought to rest, and energy is absorbed by the fluid. The theory of discontinuous motion is the basis of the well-known calculations of the resistance experienced by a plane lamina moving through a liquid, originally due to Kirchhoff, and subsequently developed by Lord Rayleigh, Love, Michell and others.

The case of a ship floating in water rocking from side to side differs from these ideal cases in the properties (1) that waves are produced on the surface, (2) that water is not a *perfect* fluid ; so that energy is being continuously absorbed by wave-formation, and by the viscosity of the water. If the ship has no sharp keels projecting into the water, these are the only causes which retard the rolling of the ship, but as soon as keels are attached discontinuous motions are set up, which involve a further absorption of the energy of rolling, and the oscillations subside much more rapidly. If we imagine the ideal case of a ship floating in a perfect liquid, the surface of which is coated with a perfectly rigid sheet of ice entirely preventing any waves from forming, but just allowing free play for the ship to roll, the oscillation would continue indefinitely, provided the ship had no sharp projecting keels. If, however, bilge-keels were attached, the oscillations would gradually die down, the energy of rolling being absorbed by the production of discontinuous motions, and being transformed into kinetic energy of the liquid.

The object of this investigation is to show that the efficiency of bilge-keels in modifying the rolling of ships may be greatly increased by the action of the sides of the ship itself, and is so increased in a ship of section approaching to a rectangular form, provided that the bilge-keels are attached at the protruding

[1] Abstract of a paper read before the Institution of Naval Architects.